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ABSTRACT

Psychological research has identified a number of cognitive processes and language abilities that are involved in the development of reading skills. This paper examines the ways in which research findings relate to current curriculum practices in such areas as learning letters and sounds; developing auditory perception skills; word recognition; learning the meaning of words; and reading and understanding sentences. The author then shows how information-processing theories of learning have been used in analyses of reading-comprehension instruction in beginning reading programs. The conclusion of the paper notes that much current theory and research has limited utility for informing instructional practice in reading and that the kind of psychological research that will inform instructional practice is research that is focused on instructional questions. While some current research findings can be related to curriculum design in a fairly definite way, a true measure of the relationship between psychological theory and instructional practice must depend on advances in theory and research, as well as on better documentation of current curriculum practices. (GW)

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Some Observations about Theory and Curriculum Practices in Reading

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In her paper, "Developmental Considerations for a Reading Curriculum" Dr. Athey (Athey, 1977) has reviewed some of the major findings of research on the development of psychological processes in reading. My role in this symposium is to interpret the findings of the research cited in terms of what I think its implications might be for instructional practice. Then, based on my view of what these implications seem to be, I will attempt to relate prescriptions derived from research to curriculum materials in elementary reading. The question I will attempt to address is, "To what extent, and in what ways, does reading program design reflect what we know about the development of psychological processes of reading?"

I should note, at the outset of my remarks, that I was glad that Dr. Athey had the difficult task of specifying the research knowledge base - the knowledge base that serves as a context for my paper, providing as it does a frame of reference in which current curriculum practices might be described and evaluated. Because Dr. Athey has elected to take a broad sampling of research on the development of language and cognition she has given me an opportunity to discuss the numerous issues involved in establishing ways that research can relate to instructional practice. When such research has definite curricular implications, I surveyed some elementary reading

¹In N. Glaser (Chair). "Goals for an Elementary Reading Curriculum Based on Language and Cognitive Development." Paper presented at the Meeting of the International Reading Association, Miami Beach, May, 1977.

materials to determine whether the program designers has been responsive to the findings from psychological research. My own view of psychological research is a selective one. I feel certain kinds of theory and research can provide guidance for instructional practice and help shape important curriculum issues. Other kinds of theory and research can foster irresponsible practices, when care is not exercised in interpretation. A third kind of research, while it may be interesting, is essentially irrelevant for instructional questions. The various ways that findings of research relate to current curriculum practices, I hope to outline here in my paper..

Dr. Athey has organized her review of research into areas reflecting different psychological topics like perception, cognition and language. I will follow a somewhat similar organization, from simple to complex, starting with the simple linguistic units of letters and sounds, working into the learning of words, reading and understanding sentences, then reading and understanding discourse. At times in the paper, I have had to supplement the research knowledge base.

The learning of letters and sounds.

A major research finding noted, and one that has been around for some time, is that letter recognition is mediated by the acquisition of distinctive features. The relevance of this research finding for instructional practice is that it indicates to the reading program developer, and the teacher, which letter stimuli will be most difficult to discriminate, and it indicates to the teacher or program developer which particular features of the stimulus need to be pointed out and emphasized during instruction. This particular finding from research on perception has found its way into Educational Psychology texts (Anderson & Faust, 1973; Becker, Engelmann & Thomas, 1971), books on the technology of reading instruction (Smith, 1976) and is attended to in the way in which beginning reading programs sequence graphemes.

More specifically, developers of most contemporary programs attend to the visual confusability of letters by separating highly confusable ones, i.e., putting them in later in the grapheme sequence. This technique illustrates application of principles of sharpening a discrimination by beginning with minimally confusable stimuli in the set to be discriminated (e.g., b and s) and then proceeding to more confusable stimuli (e.g., b vs. d). Explicit mention of attention to visual confusability of letters was given in documentation of the Stanford reading program (Fletcher, 1976) and the LRDC reading program (Beck & Mitroff, 1972). In my examination of the grapheme sequence of the Ginn 720 program, I noted that the grapheme sequence illustrates attention to this factor. Specific mention is made of the principle of proceeding from maximal differences to minimal ones and is contained within the 720 Teacher's Manual (Ginn, Level 1, p. T-17). It also ought to be noted that Distar attends to confusability of letters by using a typography that exaggerates certain letter features, so as to reduce their confusability. Furthermore, in their explication of the theory of teaching tasks that lies behind the Distar program, Becker, Englemann and Thomas (1971) specifically note ways in which teachers, when they are doing real time teaching, can draw students attention to critical features of letters.

For the most part, I think it safe to say that attention to visual confusability of letters is a recognized part of reading program design. However, it is important to note that visual confusability is not the only factor program designers must consider when designing a grapheme sequence. Considerations must jointly be given to acoustic confusability as well, and to the types of words that can be generated then presented to children to decode on the basis of the sequence to date. One wants to be able to

present words that are in the child's vocabulary, since the focus in beginning reading is to provide the child with a strategy for translating print to language that is already familiar. One wants the child to be decoding words that are in his speaking and listening vocabulary.

Our work on the analysis of two beginning reading programs at the LRDC (Beck & Block, 1976) has shown that programs can differ greatly in the meaningfulness of the words that are generatable at given points in the program. In general, it is fact of life in reading program design that you can rarely consider one aspect of a developmental sequence independently of other aspects. It is quite possible that when adapting to the difficulties inherent in one factor, you may unintentionally increase difficulty associated with other factors. This same point was made by Bartlett (1976) in her review of the Distar program. Bartlett argued that because of the unusual typography of the Distar program, a typography designed to maximize letter discriminability, children learning to read with the program would be unable to read standard orthography and hence would not have access to certain natural reinforcers for reading (like reading newspapers to their parents). This would, in turn, have certain undesirable effects on children's motivation to read and naturally depress reading achievement. While the reality of these side effects is actually an empirical question, I want to use this argument to make an important point about the utility of certain research findings for designing instructional practices.

Curriculum design in reading and in other disciplines has many elements of an operations research problem. It is an attempt to maximize multiple outcomes while minimizing related potential costs, and the program variables you manipulate are interdependent, to various degrees. This means that if

you decide to minimize confusability through the grapheme sequence, then you may restrict the type of words you can generate. If you decide to use an exceptional typography, then you may, according to Bartlett at least, restrict a child's ability to read conventional print. Therefore, when one reads research that suggests a design for particular reading program factors, one must always question whether such factors are free to be manipulated or whether, and to what extent, they are jointly constrained by other factors. What seems to be a sensible idea from the point of view of research may be inadvisable or simply undoable in actual practice. Therefore, while some findings from research can provide guidance for design, the real utility of such findings must be evaluated in the context in which they are to be applied.

To continue our discussion of the research knowledge base related to letters and sounds, along with processes of letter recognition, Dr. Athey notes research on auditory processes as relevant to consider for reading program design. On this point, I think that the research that has been most significant in influencing program practices has emerged from the psychometric/correlational tradition. This research has consistently shown that significant relationships exist between performance on various tests of auditory abilities and reading achievement. This had led, in turn, to a renewed emphasis on the development of auditory abilities in current basal reading programs. This is somewhat unfortunate for care was not taken in the incorporation of these results into practice. Apparently, a tendency has developed towards viewing all tests of auditory abilities as measuring similar processes. Distinctions were not made between "general" auditory abilities and those auditory skills specific to reading and learning to

read. Do such distinctions matter? The answer on the basis of recent research is - yes.

The need for a careful definition of both visual and auditory skills required for reading was emphasized in work by Venezky (1975). Venezky (1975) noted discrepancies between the skills built in readiness programs, the skills examined by popular tests and the skills required to learn to read. On the basis of a logical analysis of the demands of a decoding task, Venezky (1975) described the nature of the auditory prerequisites for beginning reading, suggesting that they are (a) identification of a sound within a word and (b) sound matching within words. Wallach, Wallach & Dozier (1977) have followed a similar line of reasoning in pointing to the importance of a careful analysis of auditory prerequisites to reading. They noted the fact that auditory discrimination, i.e., hearing the difference between different phonemes, is different from phonemic analysis, i.e., selecting a word or picture name that starts with a target phoneme. In their recent study, Wallach et al., (1977) demonstrated that poor children (in contrast to middle class children) have little difficulty with auditory discrimination, but great difficulty with phonemic analysis - and the instructional implication here is that beginning reading programs ought to focus on teaching phonemic analysis, as the Wallach designed program does.

My impression from a cursory examination of the readiness components of two beginning reading programs, Ginn 720 and the Palo Alto reading program, is that the auditory skills development activities are not always focused on the requirements of the reading task. Many activities are auditory discrimination activities, they merely provide practice in hearing similarities and differences between language stimuli. Therefore, my impressions of what

reading programs do in actual practice, is that they may provide practice in auditory activities that children can already easily do. If this is true and my impression is verified by more careful documentation, then instructional time is being used in an ineffective manner. Another observation related to the auditory skills required for reading is that the nature of correspondence instruction suggested by various programs differs in the extent to which well developed auditory skills are required to profit from the instruction (Beck & Block, 1976). Some children, particularly poor children (see Wallach et al., 1977), may well have difficulty learning to read when certain programs, like the Ginn 720 program, are being used.

To summarize my remarks here about research on auditory perception, I think in the light of certain arguments and recent data, particular care must be taken in the interpretation of the research. First, we must go beyond an initial logical observation that auditory perception has a role in reading, and beyond the empirical finding that certain tests of auditory discrimination correlate with reading. We must do a careful analysis of the auditory requirements of the learning to read task, and obtain careful skill descriptions, then we must design our instructional activities so they teach toward the specific skills identified. As you may infer from my suggestions here, we cannot directly apply the findings from some types of psychological research. There is an additional link of consideration. Such considerations come into play when curriculum technologists analyze the behaviors and processes involved in learning to read. Then, they use this analysis in judging whether and to what extent findings from research are relevant to curriculum practices. It is important that when attempting to use research in designing instructional practices, analysis of the target

learning task is conducted. Certainly, some curriculum designers in reading perform such analyses (Resnick & Beck, 1975, and the Distar program as a case in point) from which they obtain content specifications, but we have no way of knowing how widespread the use of such analytical models is. The main point here though in relation to auditory skills development - current programs may require more facility than they actually take responsibility for developing.

From research on recognition of simpler units like letters and sounds, Dr. Athey cites the classic work of Weber on the development of word recognition. To review, Weber (1970) found by analyzing the errors of beginning readers that the majority of the errors were in the misreading of individual words, not in misinterpretation of meaning. This suggested that children in the early course of their reading are sensitive to the structures and meaningfulness of the sentences they produce, and they pay less attention to graphic information. This information coupled with related findings on oral reading errors has been interpreted in vastly different ways by reading program developers. To Beck and Mitroff (1972), developers of the New Reading System, the finding implies that there is a need within beginning reading instruction, for providing the beginning reader with strategies for using phonemic elements as cues to narrow down the semantic choice (Beck & Mitroff, 1972, p. 19). This suggests that while these developers recognize the role of syntactic and semantic clues to meaning, they view such clues as insufficient. In their view, phonemic clues come into play in cases of semantic uncertainty. They invoke Weber's research to justify their code-breaking approach.

By contrast, other reading developers would view the research on oral reading errors quite differently. Presumably, advocates of the meaning

approach would accept this research as evidence, that even in early reading, the natural tendency is to pay attention to meaning and that instruction should reinforce this natural tendency, and attempt to further develop children's ability to get meaning from semantic and syntactic cues. The use of phonetic principles to derive meaning should be de-emphasized and used only when other clues fail. For those of you who may think that code-breaking and meaning approaches are names for programs whose differences are more apparent than real, let me refer you to Popp's (1976) analysis of two beginning reading programs - Scott Foresman's (1976) Reading Unlimited, a meaning approach and LRDC's New Reading System, a code breaking approach. Popp did a detailed analysis of the instructional strategies, sequences and materials and I can assure you that the two programs are vastly different in details as well as in overall approach.

Now, just suppose that we asked the developers of two reading programs - one, a code breaking approach and the second, a meaning approach - "Does the design of your curriculum take into account the findings of Weber's and others research on oral reading errors?" It is entirely conceivable that both program developers would answer - why, yes! - for some of the reasons I have previously mentioned. Clearly, some of the same evidence on the development of word recognition processes might be cited as consonant with very different curriculum practices. Some research then without more elaboration does not, in and of itself, provide much assistance in making curriculum decisions.

Some psychological research on word recognition that is very pertinent to reading program design is research on the role of lower order skills, like decoding, on reading comprehension. A number of basic researchers have

demonstrated that rapid decoding, or automaticity, is an important skill (LaBerge & Samuels, 1974; Perfetti & Lesgold, 1976) in reading, central to comprehension. The theoretical model behind this research is the limited resource memory model, noted by Dr. Athey, that simply suggests that if you have to pause and devote your attention to decoding, your memory for what you recently read is lost and overall, comprehension will be depressed. Automated decoding develops when children have been given frequent opportunities to apply correspondences they have learned to words they encounter later. Such practice of course must occur in the task contexts in which the automated skills are to be used, i.e., in the context of reading connected text. In our analyses of beginning reading programs we (Beck & Block, 1976) attempted to determine the extent to which the Ginn 720 program provided sufficient opportunities to apply learned correspondences to connected text. We concluded that more opportunities could have been provided than were, within the constraints of their curriculum design. One current program does not optimize the conditions for learning automated decoding skills. Admittedly, this judgment was based on intuition and experience, not hard data on the amount of practice that must be provided to produce automated decoding. Such data does not exist. This finding from research suggests that we may want to renew our emphasis on decoding in the following way - we should note that not only is it important to get the word right - it is also important to get it fast.

Learning the meaning of words.

In reading program design the vocabulary development objectives shift from decoding and recognizing words in the early levels to learning the meaning of new words in the mid to upper elementary levels. As has been noted,

both breadth and depth are important in the development of word meaning. These general notions of breadth and depth are compatible with psychological theories of the development of word meaning which describe such development as the acquisition of semantic features. Semantic features theory is a psychological theory which presumes that word meanings are bundles of semantic features that serve to differentiate the target word from other words. The meaning of a word is defined by comparison and contrast to other (related) words. For example, the meaning of the word bird is derived from its contrast to a superordinate category, animal (a bird is a type of animal), its contrast to a subordinate category term (the class of birds contains robins), and its contrast to a co-ordinate category term (a comparison of bird to dog yields differences in terms of typical medium of movement, air vs. land and so forth). The properties is a type of, containment of and medium of movement are some of the semantic features that define the word, bird in terms of its relation to other words.

Semantic features theory is not elaborated as well as it needs to be for incorporation into instructional practice. That is, given sets of individual words that we might want to teach, what are the features of each word that ought to be emphasized? We cannot look to semantic features theory for answers because the state of psychological knowledge about fundamental sets of features is quite primitive. Gibson and Levin (1975) have been critical of developments in semantic features theory, noting that features have been defined too readily, so that a feature is really any aspect of a word's meaning that enables it to be categorically related to other words (p. 149). This means that semantic features theory at its present state of development provides only quite general suggestions for instructional

practice. The suggestion that may be taken into practice is the notion that, in vocabulary development, where our attention is given to the development of word meaning, we ought not just to be emphasizing individual word meaning; rather, what we might want to emphasize is domains of words whose meanings are related. That is, vocabulary development ought to focus in part on developing understanding of relationships between words, as well as the meaning of individual words. This in turn means that when we teach a word we try to place it in a taxonomic structure, for example, in teaching coyote we point out that it is an animal and that such an animal is physically similar to a dog, but different from a dog because it is a wild animal, not a pet around the house, and so forth. For those of you familiar with the theory of concept teaching behind the Distar program, you will know that this is precisely what is done in that program.

Presumably, if general features of meaning are not specifically taught by an instructional program, children are left on their own to extract general features of meaning from specific verbal contexts. Such a notion was suggested by Werner and Kaplan (1950), a study well known to reading educators, who suggested that word meaning is derived from verbal context by a process called "decontextualization." This process involves a gradual refinement in meaning in which the specific features of the context are dropped until all that remain are the semantic features which characterize the word in all contexts. This notion about the meaning learning process suggests, for one, that in order to provide for the acquisition of "general" meaning, sentence context variables should be systematically manipulated by the instructional program, with the word whose meaning is to be learned remaining constant. In the instructional materials that I (Block, 1976) and my colleagues

(Humes, 1976) have surveyed, the sentence context variable does not appear to be systematically controlled. Furthermore, in teaching strategy descriptions that are given to teachers, either by Teachers' Manuals or by reading methods texts, the important context variables are not mentioned. The means that when teaching vocabulary with a "words in sentences" method, the general meaning of a word may be hard or impossible for a child to induce from the nature of the example sentences presented.

In another paper, I have reviewed the materials and teaching methods in the area of vocabulary development. I concluded, from my review, that the area is in great need of revision, for despite the long history of attention and concern for building vocabulary effectively, little progress has been made on the development of more precise and more fully specified techniques of teaching, and testing and materials design. This situation was quite surprising to me since some of the basic instructional design concepts out of which more adequate methods could be built have been present in the instructional design literature for sometime. My point here is that while basic psychological theory, like semantic features theory, might give us suggestions for what sorts of emphases to portray in our instructional programs, if we do not have the proper instructional know-how, in the sense of being able to apply principles of instructional design and design learning tasks effectively, our best attempts to incorporate suggestions from theory into practice will be undermined by lack of skill in instructional design.

Reading and Understanding Sentences.

Let us now step up a linguistic unit from the individual word and vocabulary development concerns to the research that has been cited on children's ability to understand certain syntactic constructions. The fact that children

at certain ages have difficulty comprehending certain types of linguistic constructions has been known for some time. As early as 1969, it occurred to some reading researchers (Hatch, 1969) that since beginning reading series did not appear to carefully control for syntax, that more comprehensive studies of the development of syntax should be conducted and analyses done of the way in which syntax was handled in beginning reading texts. Such studies were done, programs were surveyed and one conclusion that emerged was that for certain constructions, there was a mismatch between what the child can understand and the language used in classroom reading books. It occurred to me what I might do is perform a similar analysis on more recently developed materials to determine whether such a mismatch is in evidence today. Such an analysis, however, would be quite in error, given the findings and interpretations of more recent research. More recent research (Lesgold, 1973) has shown that Bormuth's findings in relation to the difficulty ordering of certain syntactic constructions are not reliable. Unreliability is attributed to several factors - one is that comprehension of a given structure can vary as a function of semantic context - semantically simpler sentences with the same syntax construction are easier to understand - and the other is that variability in tests of syntactic competence may be due in part to the fact that anaphora, for example, cannot be as completely comprehended unless it and its antecedent are simultaneously in short term memory. Therefore, it would not be meaningful to expect or demand that reading programs sequence their introduction of syntactic constructions solely according to hierarchies of syntax comprehension discovered by Bormuth's and others research. Syntax is important, but must be manipulated in conjunction with semantic considerations.

Interim Summary

At this point, it is convenient to summarize some of the relations I have been stating between the findings of research and our reading curriculum practices. There are five points of interest. First, the research on visual recognition of letters has been incorporated into practices. Research on the difficulty of different syntactic constructions has problems of replicability, but syntax plus semantics could be jointly considered in the design of curriculum, but I know of no commercial program that does this at the current time. Furthermore, we ought to note that neither variable, the grapheme sequence or the type of syntactic construction, can be considered a program design variable that can be manipulated independently.

Graphemes cannot be sequenced solely according to confusability because attention must be paid to generativity, i.e., whether meaningful words for children can be built at various points in the sequence. Syntax cannot be considered independently of semantics, i.e., of the meaning content of the construction. The utility for instructional practice, of both pieces of research would have been significantly enhanced if the researchers had initially drawn their problems directly from the instructional context.

A second point is that while various kinds of auditory abilities have in fact correlated with reading, a distinction must come into play when thinking about what such findings mean for reading. The distinction entailed in this case is between "general" auditory abilities and those that are specifically required for reading and learning to read, auditory skills like phoneme analysis. My impression is that despite the goodly amount of attention paid to auditory skills development in beginning reading programs, auditory training procedures used in prereading modules are not as focused

as they need to be. Time is spent in teaching children what they can already do. Furthermore, one cannot expect that such skills will develop in later instruction in some programs at least, for later instruction requires these skills, but does not provide for their development. What is needed is a more specific targeted effort on auditory skill development and, perhaps, as I also noted, on automaticity. Note that in my discussion of auditory skills, required for reading I had to draw on research that defined those skills on the basis of what skills are required in the instructional context. In my opinion, one kind of research that is highly relevant to reading is research that has been posed with some instructionally related questions in mind.

A third observation, in relation to Weber's research on oral reading errors, was that I could see this research used as justification for two quite different kinds of curriculum practices, one a code-breaking approach and the other a meaning approach. This simply means that in my view, the research cited does not inform curriculum decisions; it gives no basis for preferring one program over another. This in turn means that without further elaboration, the research is irrelevant to certain important instructional questions. The situation could be different if the research had been posed initially with a focus on instructional questions.

For point four, I would remind you of my discussion of semantics feature theory in relation to vocabulary development. It seems reasonable to me to conclude that at this point in the development of the theory, it serves only to rationalize some existing practices that emphasize relationships between words. It does not take us beyond current practices and provides no guidance for improvement. Just suppose, however, that those researchers who are working on semantic theory development took on the job of producing a

vocabulary development program. The first problem that would be faced would be the necessity of specifying the features they would want to teach. In facing this problem directly, semantic features theory would be improved and in turn provide the rest of us with guidance in selecting the features of meaning for emphasis.

Finally, I want to note that while we may want to identify things to teach from research findings, we must simultaneously be concerned with the quality of our instructional design. Teaching tasks must be carefully specified and contingencies appropriately placed so that students actually learn what we set out to teach them. The initial context for this point was the need to systematically manipulate sentence context variables in vocabulary instruction. The point gains further emphasis from recent work by Popp (1976). In her review of Scott Foresman's Reading Unlimited, Popp (1976) noted many instances in which students would get answers correct without actually reading the textual materials. My own impression of the consistency of lessons and texts in some of the newer basals is that their consistency could be greatly improved.

To sum up then, for the moment, it is clear that my reaction to one portion of the research mentioned in Dr. Athey's broad survey is that some of the research is less useful than one might initially think for instructional practice in reading. This means that making instructional decisions and designing instructional practices in reading often places its own unique requirements on psychological research. This in turn means that some of the findings contained within the current body of psychological research are not quite adequate for making many kinds of instructional decisions, decisions that must be made when designing new practices or selecting among existing

programs. It seems appropriate, therefore, to suggest that we recognize the limitations of some research for certain questions of instructional practice. The situation could be somewhat different if such research had been posed initially with some sensitivity to instructional questions that program designers, in their work, find they must address.

A focus on information processing models of reading.

I do not want to convey the impression that psychological research useful for reading must be research targeted toward instructional questions encountered in the applied setting. When specific findings of research can be incorporated into a coherent theory, the general principles of the theory can be useful in analyzing current instructional practices. In her review of the research, Dr. Athey noted recent research in memory leading to information processing models of reading. I am glad she noted this work for it is one part of the framework that governs our curriculum analysis work at the Learning Research and Development Center. I would like to describe the main points of that work to you, for it will give you an idea of how we are attempting to related selected psychological theory to what exists in instructional practice.

Our approach to the analysis of elementary reading programs is significantly influenced by selected information processing theories of learning, memory, and performance from the field of cognitive psychology (Chi, 1976; Perfetti & Lesgold, 1976; Rumelhart & Ortony, 1976) and by models of prose processing (Frase, 1975). In our instructional analysis work, we also work with specific definitions of beginning and intermediate reading. In our view, the main purpose of beginning reading is to teach decoding from print in the context of meaning. The main purpose of intermediate reading

is to lay a foundation of language understanding, and text processing facility that will permit understanding of a variety of textual materials, at some criterion level of acceptability, by the time a child leaves sixth grade. Although broad, these definitions focus our attentions differently, and provide a second part of the framework for our evaluations when we analyze elementary reading programs.

In a recent paper, my colleague Isabel Beck and I analyzed several characteristics of the instruction provided by two quite different beginning reading programs, the Ginn 720 program (Ginn, 1976) and the Palo Alto (Palo Alto, 1973) reading program. We focused most of our analysis on the nature of the decoding instruction, both phonics instruction and sight word instruction. We analyzed quite a number of program components. The components we selected were chosen on the basis of both traditional pedagogical issues (e.g., whether a program developed a set for regularity or a set for diversity) and newly identified requirements for pedagogy (e.g., the need to develop specific kinds of auditory skills for decoding success). Some new requirements for pedagogy, like automaticity, were identified for analysis because of the recent findings of psychological research which pointed to the importance of automated decoding for comprehension. Of special interest is our analysis of the instructional strategy suggestions contained within Teachers' Manuals of both programs. These strategy descriptions provide detailed and specific suggestions for what the teacher should say, show and do when she teaches letter-sound correspondences. Our analysis of these strategy suggestions was done with an explicit recognition of characteristics of a limited resource processing system, and the differing demands that alternative forms of correspondence instruction can make on that system.

As an example, in the Ginn 720 series, when a teacher presents the /short i/ phoneme, she says that it's the "vowel sound in fish." In the Palo Alto program, the teacher produces the sound in isolation, i.e., she says that a certain word begins with the sound /i/. These different ways of referring to the /short i/ sound may have several effects: putting the /short i/ in fish may influence the precision with which the child encodes the target sound. Saying the sound in isolation removes the need for extracting it from fish, which in turn lessens the cognitive demand of the correspondence learning task. In addition, the Palo Alto teacher uses what is called a Spelling Pocket which contains manipulable cards on which letters and graphemes are printed. When children engage in phoneme analysis activities, the phonemes are associated with their individual graphemes. In so doing, the graphemes might well provide memory support for re-perceiving the sound stream, which is necessary for learning the association between the set of letters (the graphic stimulus) and the word (the aural stimulus). However, the Ginn program did not systematically provide for such support as this. Our analysis showed there were distinct differences in the strategies of phonics instruction between the two programs, with the Palo Alto program imposing less memorial and perceptual demands. Presumably, the phonics teaching strategies in the Palo Alto program would better adapt to the limited resources of the human information processing system. As you can see, we have applied our concept of limited resources in the memory system to make distinctions between reading program practices. Clearly, in order to teach all children to read, improvements may be needed in phonics teaching strategies in the direction of lessening task demands.

We expect to continue to use information processing theory to perform

analyses of reading comprehension instruction. In a paper at this convention, Beck (1977) presents a number of analyses of the reading comprehension instruction in one leading basal series. I will not reiterate her findings here but I will describe those parts of the analyses that Beck presents that have been stimulated by attention to theory and specific findings of research. Current theories suggest that reading comprehension is a function of a student's knowledge, his strategies for processing text and the way in which knowledge and strategies relate to an information processing system with a limited capacity.

We use theory in reading comprehension, and the co-ordinate body of experiments, in two ways. First, we use concepts and methods of research to better analyze the conditions of learning and the changes in those conditions, that are obtained in conventional classroom materials. In psychological research, methodologies have been created to analyze the content of the text for several content units - individual propositions, logical implications, superordinate semantic structures - so we can use such methodologies to create better descriptions of the stimulus, i.e., the material children read. Research also segments complex learning activities into component parts and makes certain distinctions within parts that can be carried into analysis of materials. In her use of this feature, Beck (1977) plans to analyze the purpose for reading section in basals, looking at whether the purpose is general vs. specific, in an analogue of work by Frase Rothkopf on learning goals and directions. She also plans to analyze the nature of output requirements after reading text, in an analogue of work performed by Rothkopf and Voss. Current research has, in effect, helped us to sharpen our system of analysis of conventional classroom materials and learning episodes.

In addition to using research to sharpen our methods of describing current materials, we are also influenced by a view of the reading process that such research suggests. Theories of reading comprehension suggest the component processes of comprehension, and they make important points about the role that knowledge plays in comprehension. From these theories about the nature of reading competence, we can begin to pose hypotheses about possible requirements for pedagogy. Then, we can analyze current materials to determine if such requirements could be met with current materials. We used this approach in looking at automaticity, a component process of comprehension, that must be developed in classroom learning episodes. Another example of this approach emerges from several current theories of comprehension which point to the importance of certain kinds of semantic structures for comprehension. It has been suggested that these semantic structures might be different for different knowledge domains like biology, history, or mathematics (Greeno, 1976). The problem for reading pedagogy would then be to insure that structures necessary for comprehension in the subject domains do indeed get built up. Several types of curriculum analyses could be done to get at this question - for example, one could look at the stories children read to see if they adequately represent the various subject domains. Then, one might want to do a detailed analysis of the story content and post question content to see if contingencies exist for producing learning of the particular semantic structure in question.

I do not want to convey the impression that all we need to know for evaluating current curriculum materials is contained within the current body of psychological research. This simply is not true and currently, analyses of curriculum materials are constrained by the state of the art in psychological

research. It is one thing to have detailed descriptions of comprehension teaching practices and quite another to be able to evaluate those practices as exist. We can have careful documentation of the number and various classes of questions and how these numbers and proportions of types of questions change across the school years, but in order to be able to evaluate the quality of such a developmental sequence, we must have a research base to refer to. Such a knowledge base would contain a theory of how reading comprehension is acquired and how questions contribute to that acquisition and then how, within the constraints of reading curriculum design, development decisions are best made. Such a knowledge base of this kind currently does not exist.

To some, it may seem naive to suggest that evaluation of curriculum practices is constrained by the state of knowledge in psychological research. After all, there are a great many theories of reading that have some psychological basis. The journals are full of research reports thought relevant to reading. However, it is most important to note that much of the theory and much of the research has limited utility for informing instructional practice in reading. In the earlier portion of this paper, I gave several examples of such research. Much of the research and much of the theory does not provide us with the kind of information we need. The kind of psychological research that will inform instructional practice is the kind of research that is conducted with an instructional point in mind - either to inform developer decisions or to sharpen understanding of basic psychological processes that are a part of reading. This is to be contrasted with psychological research that is done for reasons unrelated to reading or without concern for application. In recent writings, Glaser (1976) had made explicit

the requirements on psychological research and theory imposed by a concern for applications to instructional design.

Because many things we need to know to evaluate current curriculum practices are not evident in current research, it is true that in some sense, development is ahead of research. Developers have made many decisions about program design, without research evidence and in the absence of an explicit rationale provided by theory. This is not to say that such decisions are bad - many developers are themselves strong theorizers (see Resnick & Beck, 1975). However, theory driven by intuition, and the rationale implicit in design decisions must be made explicit, so as to be tested. Current commercial programs exert major control over the ways we teach reading. A convenient way to make developer intuition explicit is to conduct careful analyses of commercial curriculum materials and suggested practices. In this way, we can get reasonably precise descriptions of current practices so as to identify the hypotheses that guide them. These hypotheses can then be tested in later research which in turn can be used to revise some practices, and empirically validate others.

In conclusion, I would say that while we can relate some current research findings to our curriculum design in a fairly definite way, we currently cannot obtain a true measure of the actual relationship between psychological theory and instructional practice. The extent of such a relationship must depend upon advances in theory and research, as well as better documentation of current curriculum practices. As an educational psychologist, I work directly with students in reading who are, at least initially, quite skeptical of the relevance of research for practice. In this setting, I am glad to have entered the field of reading through my

work on the analysis of curricular practices. My curriculum analysis work serves as an important bridge between theory and practice. It is more meaningful to present the human information processing system when it can be related to some issues in phonics teaching. Discussing practical questions in the context of research allows both my students and me a better understanding of each others' perspective. With this kind of bridge between theory and practice, I think we will eventually find a greater and more sustained influence of psychological research on the nature of reading practice.

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